ALLION USA

WIRELESS BLU-RAY DISC PLAYER

COMPETITIVE ANALYSIS

WHITE PAPER

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Rev 1.0

Visit our Web Site at: www.allionusa.com

Introduction

Many Blu-ray Disc™ players today have additional features such as Wi-Fi® connectivity and cloud streaming. With these features, end users can place their device anywhere in the home (assuming Wi-Fi access is available) without having to worry about network cables and enjoy their device for more than just watching Blu-ray movies. However, not all Wi-Fi capable Blu-ray Disc players offer the same features, functionality, and performance.

Allion's competitive analysis performed the following tests across 13 different wireless Blu-ray Disc players to evaluate the overall performance of each device primarily focusing on the Wi-Fi component:

- Feature Set Comparison
- System Startup Time
- Application / Media Load Time
- Reliability / Longevity
- Wi-Fi Signal Attenuation vs. Media Streaming Experience (RF Chamber)
- Over-The-Air (OTA) User Experience (3000-sqft House)
- AP Interoperability

In order to rank each of the devices, Allion has created a scoring method to score each device depending on the performance in a given test (total of 20 tests):

Allion scoring guide (unless otherwise noted):

- Excellent = 10pts
- Above Average = 7pts
- Average = 5pts
- Below Average = 3pts
- Poor = 1pt

Max total points possible = 200pts

Wireless Blu-ray Disc Players Tested

The *"Allion USA Wireless Blu-ray Disc Player Competitive Analysis White Paper*" summarizes the features and performance of 13 different wireless Blu-ray Disc players:

1. LG BP320
2. LG BP520 *requires Cisco USB Wi-Fi dongle
3. LG BP620
4. Panasonic DMP-BDT220
5. Panasonic DMP-BDT320
6. Panasonic DMP-BDT500
7. Samsung BDE5400
8. Samsung BDE5700
9. Samsung BDE5900
10. Samsung BDE6500
11. Sony BDP-S3100
12. Sony BDP-S5100
13. Toshiba BDX3300KU

All devices were tested with default settings.

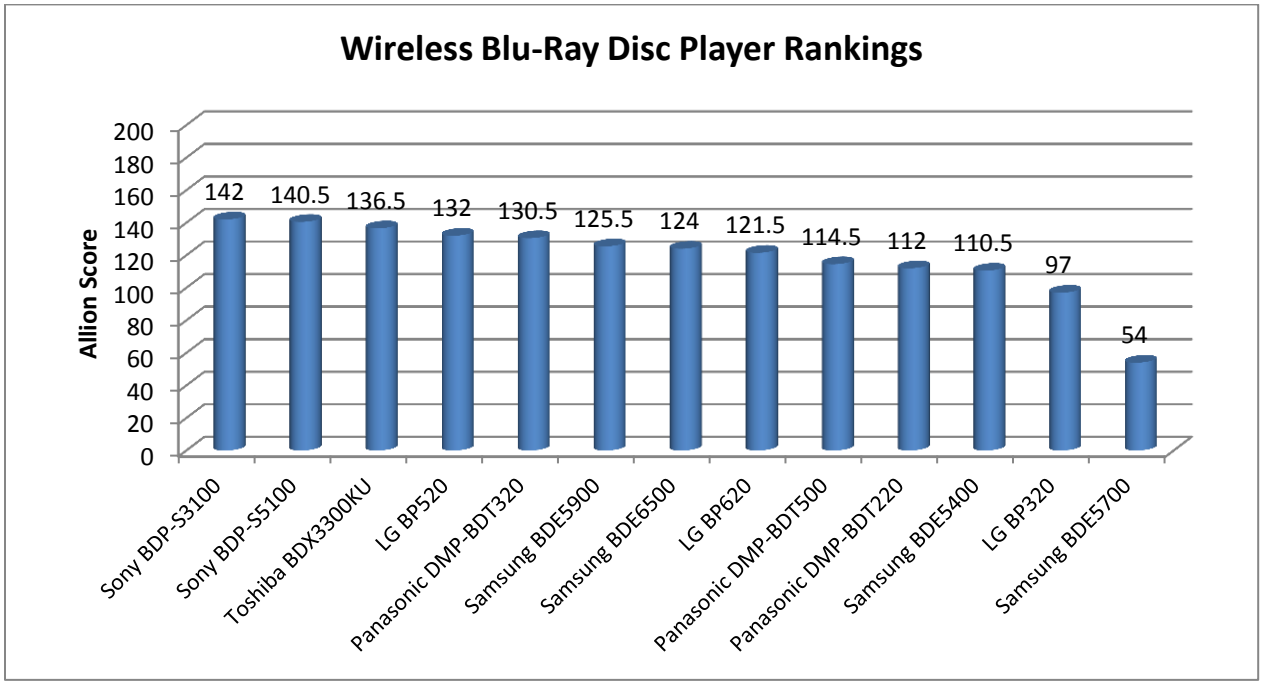
The following reference access point was used to collect measurements:

- NETGEAR WNDR4500 / N900 3x3 802.11a/b/g/n (tested on 2.4GHz)

Conclusion

This study shows how each wireless Blu-ray Disc player compares to another in a given user scenario, revealing the strengths and weaknesses of each device. Some tests were performed inside an RF chamber to baseline the performance in an ideal RF environment, while some tests were performed at Allion's 3000-sqft test house to simulate a real-world scenario.

Based on the Allion scoring method and tests performed, the Sony BDP-S3100 ranked 1st with the most points. As discussed in more detail below, the Sony BDP-S3100 performed well across all tests showing strengths in quick app load times, stable streaming experience, and an overall good wireless coverage. The higher end model S5100 which supports 3D viewing also exhibited similar performance as the S3100 ranking 2nd. With both the S3100 and S5100 outperforming others, Sony was the clear winner in this study.

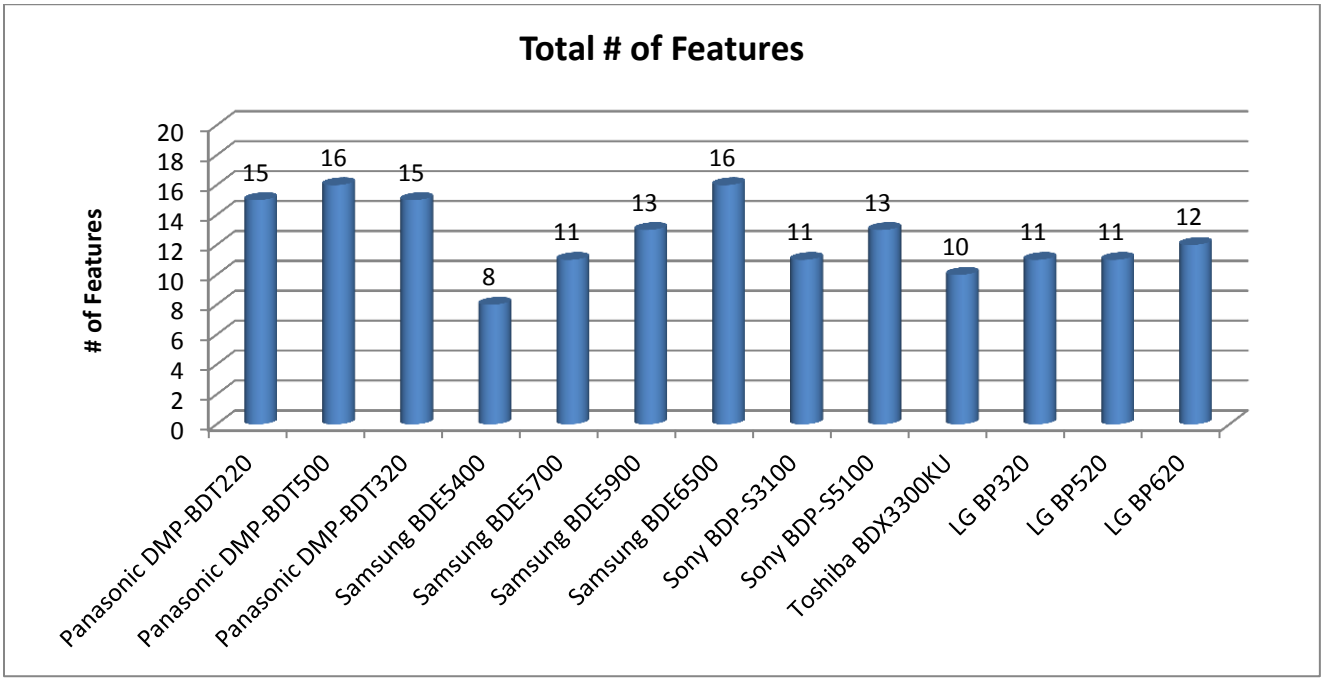


Graph above shows both Sony devices outperforming all other devices

NOTE: Summary of scores available in "Appendix"

Feature Set Comparison

This test compares the number of available features on each device. All devices supported popular features such as cloud streaming (Netflix / YouTube), HD (1080p) support, and DLNA. However, several devices were equipped with additional capabilities such as web browsers, quick start (feature that allows faster system load times), and dual band Wi-Fi radios, which accounted for differences in the score. As shown below, the Panasonic DMP-BDT500 and Samsung BDE6500 offered more features than other devices.



DUT / Features	3D	Wi-Fi	Wi-Fi Direct	Cloud Streaming	HD	DLNA	Web Browser	# of HDMI	# of USB	LAN	WPS	Dolby Digital	Digital Audio Optical Port	SD Card Slot	Quick Start
Panasonic DMP-BDT220	1	1	1	1	1	1	0	1	2	1	1	1	1	1	1
Panasonic DMP-BDT500	1	1	1	1	1	1	0	2	2	1	1	1	1	1	1
Panasonic DMP-BDT320	1	1	1	1	1	1	0	1	2	1	1	1	1	1	1
Samsung BDE5400	0	1	0	1	1	1	0	1	1	0	1	1	0	0	0
Samsung BDE5700	0	1	0	1	1	1	1	1	1	1	1	1	0	0	1
Samsung BDE5900	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
Samsung BDE6500	1	1	1	1	1	1	1	3	1	1	1	1	1	0	1
Sony BDP-S3100	0	1	0	1	1	1	1	1	1	1	1	1	0	0	1
Sony BDP-S5100	1	1	0	1	1	1	1	1	2	1	1	1	0	0	1
Toshiba BDX3300KU	0	2	0	1	1	1	0	1	1	1	1	1	0	0	0
LG BP320	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0
LG BP520	1	1*	0	1	1	1	0	1	1	1	1	1	1	0	0
LG BP620	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0

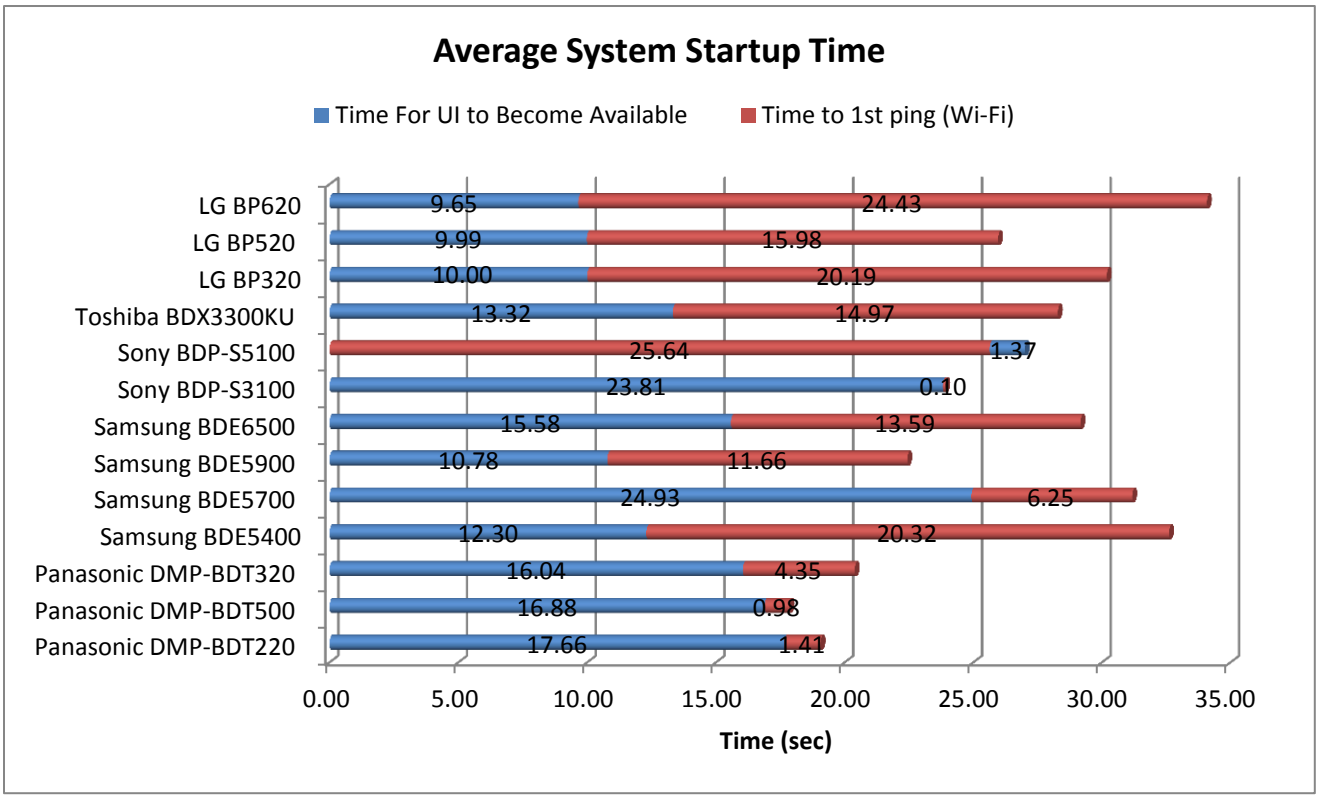
The Panasonic DMP-BDT500 and Samsung BDE6500 were tied for most number of features

System Startup Time

A fast loading Blu-ray Disc player would allow users to start using their device quicker upon startup. This test measures the time it takes for a device to start up and re-connect to the Wi-Fi network. The goal was to measure both the time it takes to load the Graphical User Interface (GUI), as well as the Wi-Fi re-connection time to understand how the two components effected the total load time.

Test method:

1. Power button pressed
2. Measured time until Graphical User Interface (GUI) became available to user
3. Measured time until Wi-Fi got re-connected (external PC continuously pinging the device to check for successful ping responses)



Data shown are averages of 3 trials

NOTE:

- Sony BDP-S5100 connected to Wi-Fi before the GUI became available
- Tested ~50ft from AP (WPA2-PSK w/ AES)
- Quick Start was disabled on all devices (disabled by default)

GUI Load Time:

All three LG devices exhibited the fastest GUI load time allowing the user to start browsing the system faster than any other device. However, the Wi-Fi did not re-connect as fast as other devices requiring the user to wait until they can access network contents.

Wi-Fi Re-connection Time:

All Panasonic devices and the Sony BDP-S3100 exhibited quick Wi-Fi re-connection times. While the GUI load time was not as fast as the LG devices, the quick Wi-Fi re-connect time on all three Panasonic devices resulted in the fastest total load time.

On a side note, devices that supported “Quick Start” exhibited significantly faster system and Wi-Fi re-connection times. Some devices remained connected to the Wi-Fi network regardless of the system power state. However, the drawback of this feature is that it is accompanied by a constant power draw.

Application / Media Load Time

Similar to the System Startup Time, this test measures the time it takes for a cloud streaming app to load and begin playing a media (audio/video) upon pressing “Play”. Three different apps (Netflix / Pandora / YouTube) were tested to observe performance deltas across the apps. Both the app load time and the time to begin streaming audio/video were measured to understand the impact on total load time.

The results varied for each device depending on the app used. List below shows the top 2 performing devices for each category:

Netflix:

- App load time: Sony BDP-S3100 and S5100
- Time to playback: Samsung BDE5900 and 6500

Pandora:

- App load time: Sony BDP-S3100 and S5100
- Time to playback: Samsung BDE5900 and 6500

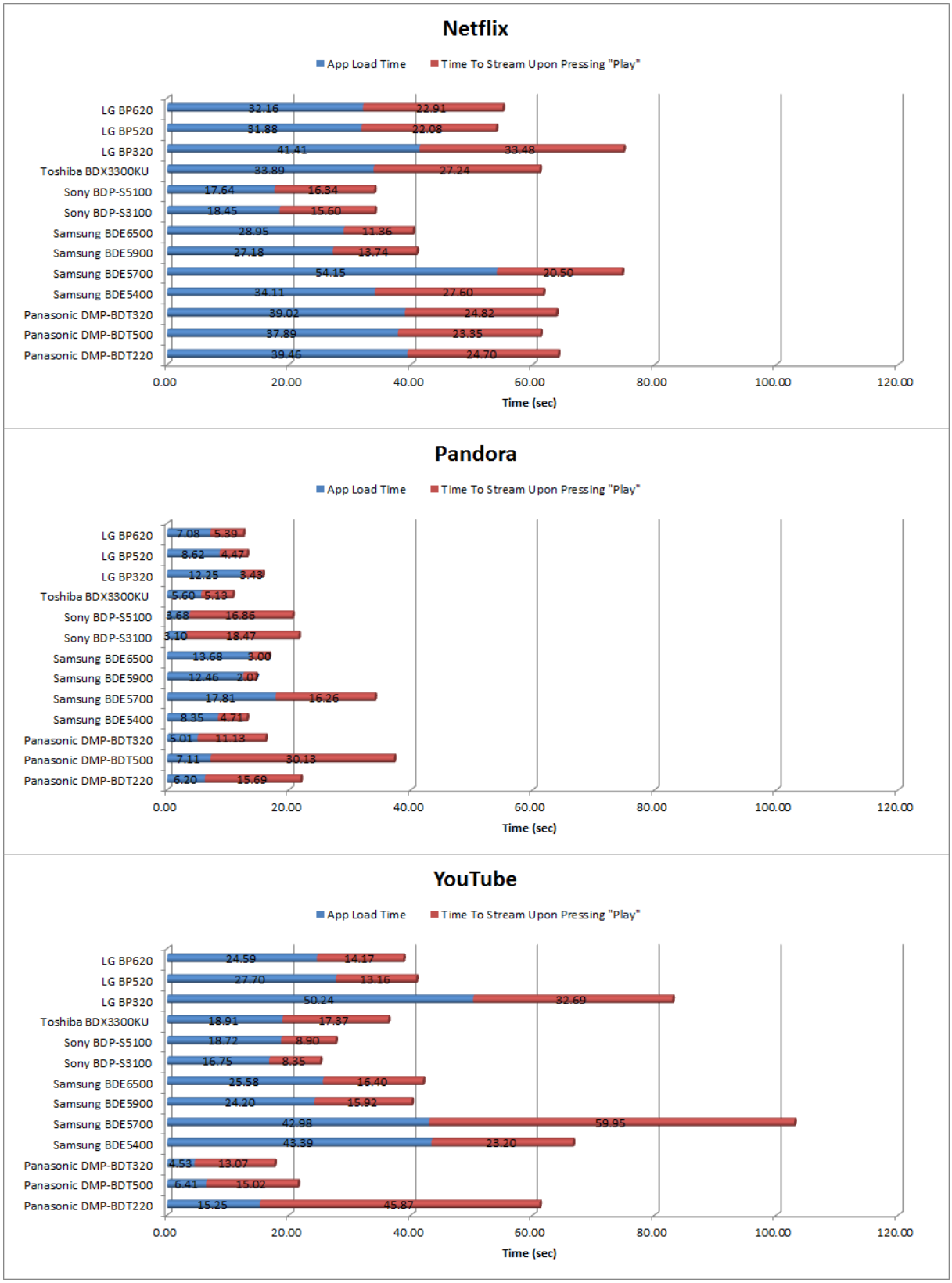
YouTube:

- App load time: Panasonic DMP-BDT320 and 500
- Time to playback: Sony BDP-S3100 and S5100

As shown above, both Sony devices ranked in the top 2 performing units across all apps for the two types of tests performed.

NOTE:

- Tested ~50ft from AP (WPA2-PSK w/ AES)
- Contents used:
  - Netflix: “Switched At Birth”
  - Pandora: “Mix Station”
  - YouTube: “People Are Awesome 2013”



Data shown are averages of 3 trials

Reliability / Longevity

This test verifies that a standard length movie on Netflix (2-2.5hrs) can be viewed without any issues during the duration of the movie. Issues such as intermittent buffering, Wi-Fi disconnects, blurry image …etc. were all noted and considered in the scoring.

Both the Samsung BDE5400 and 5700 exhibited multiple issues during playback:

1. Occasionally, the video would stop playing with an error message indicating the Wi-Fi had disconnected (reproduced multiple times). To fix, user had to exit the app and navigate to the settings page to re-connect.
2. The video paused frequently in the middle of playback to buffer.
3. The video quality was standard definition (SD) during the majority of playback showing blurry images on the screen.

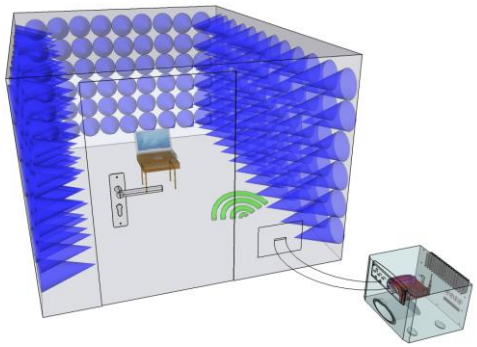
All other devices did not exhibit any major issues during testing.

Device	Signal Strength (# of bars)	Notes \ Comments
Panasonic DMP-BDT220	4 out of 5	Occasionally scaled back to SD quality. No major issues observed.
Panasonic DMP-BDT500	5 out of 5	Occasionally scaled back to SD quality. No major issues observed.
Panasonic DMP-BDT320	4 out of 5	Occasionally scaled back to SD quality. No major issues observed.
Samsung BDE5400	5 out of 5	Occasionally scaled back to SD quality. No major issues observed.
Samsung BDE5700	4 out of 5	Frequent Wi-Fi connectivity drops and buffering. Video was frequently scaled back to SD quality.
Samsung BDE5900	5 out of 5	Frequent Wi-Fi connectivity drops and buffering. Video was frequently scaled back to SD quality.
Samsung BDE6500	4 out of 4	Occasionally scaled back to SD quality. No major issues observed.
Sony BDP-S3100	67% (No signal bar indicator)	Occasionally scaled back to SD quality. No major issues observed.
Sony BDP-S5100	67% (No signal bar indicator)	Occasionally scaled back to SD quality. No major issues observed.
Toshiba BDX3300KU	64% (No signal bar indicator)	Occasionally scaled back to SD quality. No major issues observed.
LG BP320	3 out of 4	Occasionally scaled back to SD quality. No major issues observed.
LG BP520	3 out of 4	Occasionally scaled back to SD quality. No major issues observed.
LG BP620	2 out of 4	Occasionally scaled back to SD quality. No major issues observed.

NOTE:

- Tested ~50ft from AP (WPA2-PSK w/ AES)
- Netflix video = “Bad Boys II”

Wi-Fi Signal Attenuation vs. Media Streaming Experience



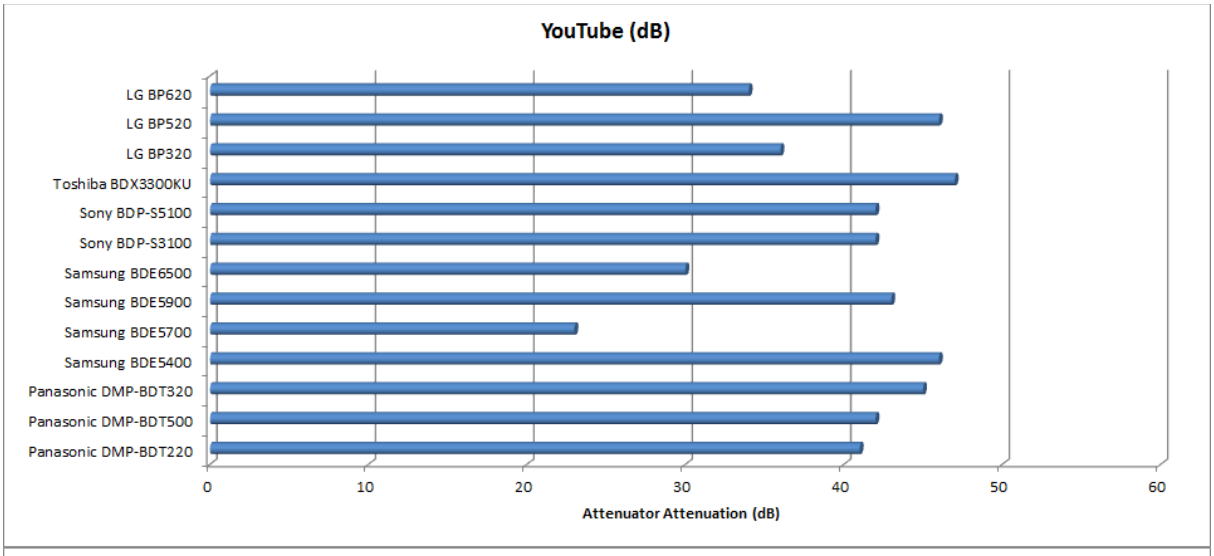
Many factors contribute to the range of a wireless device. Different chipsets, software drivers, physical antennas, case enclosures …etc., can all have an impact on the RF sensitivity of a device. This test compares the max Wi-Fi range of each device. Allion's solution incorporates a large anechoic chamber (3m x 3m x 3.5m) coupled with inline programmable attenuators and butler matrix to simulate multi-path typically seen in an over-the-air environment.

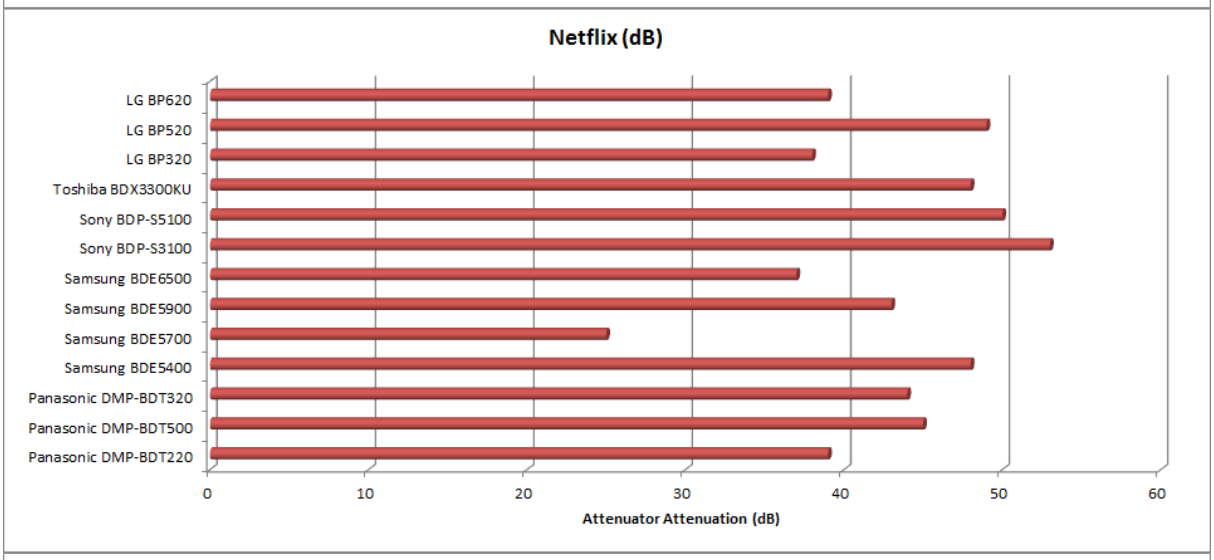
Two areas were evaluated for each device using this environment:

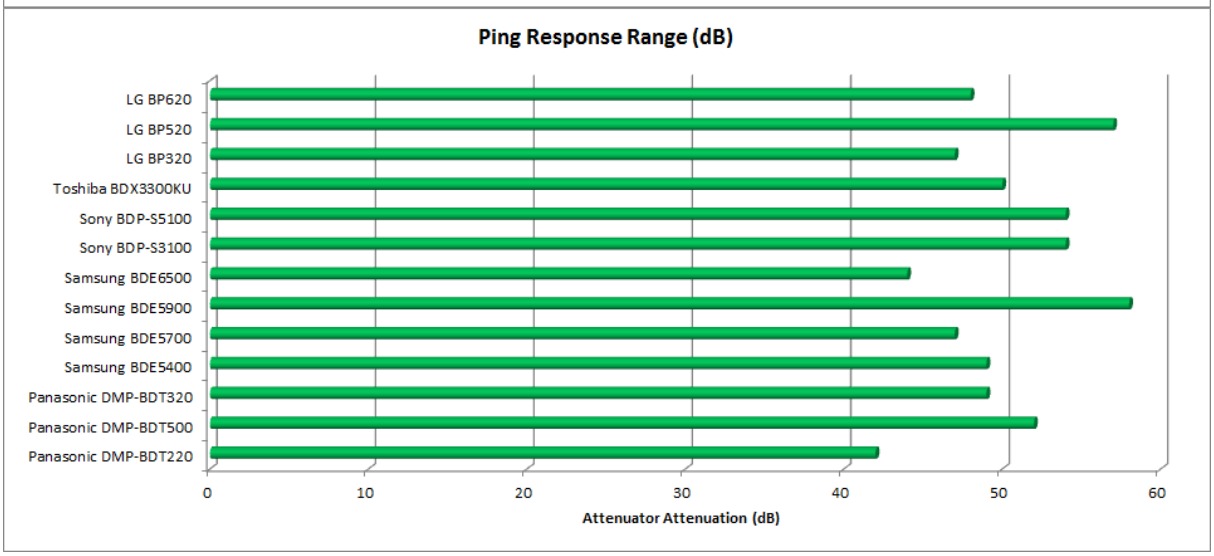
1. Understand the ***max attenuation that can be applied*** while watching Netflix / YouTube without presenting any issues (buffering, disconnects, artifacts …etc.)
2. Understand the ***connectivity range*** of the device

As shown in the graph, the Samsung BDE5700 exhibited poor range for both YouTube and Netflix streaming while other devices did not have any issues at the same attenuation level. The BDE5700 frequently exhibited long loading times and paused in the middle of the video to buffer, making it difficult to watch any video. On the other hand, the Toshiba BDX3300KU and Sony BDP-S3100 were able to stream online contents without any issues when more attenuation was applied.

The ping response range testing was performed to observe the disconnect point of the device. The Samsung BDE5900 had the longest range, but this usually does not mean it has a better streaming experience at edge locations. As shown in the graph, the BDE5900 did not have the longest range in either the YouTube or Netflix testing. However, the data points collected are useful in understanding the connectivity range vs. range to pass data traffic.







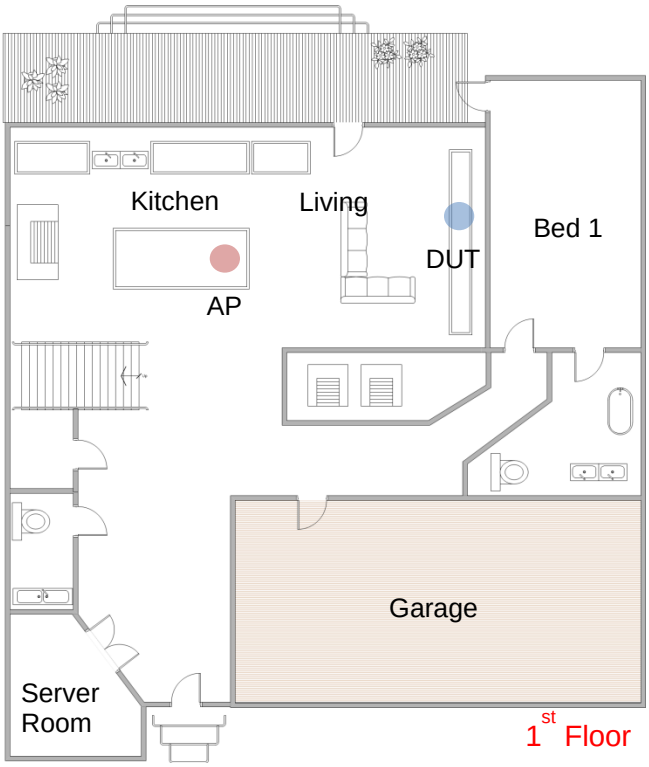
Data shown are averages of 3 trials

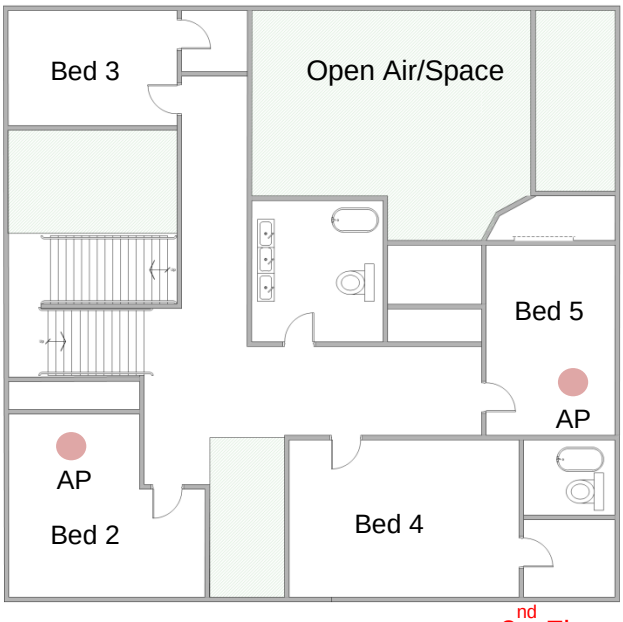
Over-The-Air (OTA) User Experience (3000-sqft House)

Similar to the previous test performed in the chamber, this test evaluates the Wi-Fi range of a device in a real home. Allion's 3000-sqft house is a typical 2 story Pacific Northwest home. The floor plan of the house is shown below.

Three areas were evaluated for each device using this environment:

1. Verify the ***user experience*** when streaming Netflix / YouTube when the AP is placed in three different locations (near, middle, far)
2. Measure the ***PHY rate (Mbps)*** of each device while performing step 1 via a Wi-Fi sniffer (AirPcap NX) to quantify the results
3. Correlate the results against the tests performed inside the chamber





The following observations were made during testing:

- The Toshiba BDX3300KU streamed both Netflix and YouTube videos at HD quality at all locations and did not present any issues. The high PHY rates captured between the Toshiba and the AP indicates the large amount of data traffic the device is capable of transmitting and receiving.
- The Samsung BDE5700 exhibited multiple issues at bedroom 2 (far). YouTube would halt regularly to buffer and Netflix had a considerably lower resolution at this location, which made viewing difficult.
- All other devices only exhibited minor issues (blurred image for several seconds) at far locations, and did not present any major issues.

The solid performance by the Toshiba BDX3300KU and the poor coverage exhibited by the Samsung BDE5700 were both in-line with the tests performed in the Allion RF chamber ("*Wi-Fi Signal Attenuation vs. Media Streaming Experience*"). While no OTA environment is the same due to the structure & materials of the building, neighbor interference, multi-path …etc., the data collected is a good indicator of the wireless performance of a device.

Device	Kitchen		Bedroom 5		Bedroom 2	
	YouTube	Netflix	YouTube	Netflix	YouTube	Netflix
Panasonic DMP-BDT220	B	B	B	B	B	B
Panasonic DMP-BDT500	B	B	C	C	C	C
Panasonic DMP-BDT320	B	B	B	B	C	C
Samsung BDE5400	B	B	C	C	C	C
Samsung BDE5700	B	B	C	C	D	C
Samsung BDE5900	C	B	C	B	C	B
Samsung BDE6500	B	B	C	C	C	C
Sony BDP-S3100	B	B	C	B	B	B
Sony BDP-S5100	C	B	C	B	C	B
Toshiba BDX3300KU	A	A	B	B	B	B
LG BP320	B	B	C	C	C	C
LG BP520	C	B	C	B	C	B
LG BP620	C	B	C	C	C	B

PHY Rate Legend:
A: Excellent (PHY Rate: 65+Mbps)
B: Great (PHY Rate: 40-64Mbps)
C: Good (PHY Rate: 20-39Mbps)
D: Fair(PHY Rate: 7-19Mbps)
E: Poor (less than 7Mbps)

Note:

- Better PHY rate does not necessarily equate to a better user experience
- Contents used:
  - ✓ Netflix: "Switched At Birth"
  - ✓ Pandora: "Mix Station"
  - ✓ YouTube: "People Are Awesome 2013"

AP Interoperability

The purpose of this test was to verify the Blu-ray Disc players can successfully connect to different AP's currently available in the market. Based on Amazon market sales and popularity, 10 different AP's were selected to perform security suite testing across all 13 devices.

Security types tested (if supported):

- Open-None
- Open-WEP
- Shared-Key WEP
- WPA-PSK w/ TKIP
- WPA2-PSK w/ AES
- WPS (PIN / PBC)

Three devices exhibited connectivity issues on certain AP's with a particular security setting (all other devices passed):

AP	*PASS / FAIL*
Linksys WRT54GL 802.11b/g	All devices passed
Linksys E1000 802.11b/g/n	All devices passed
Linksys E1200 802.11b/g/n	All devices passed
Linksys E2500 802.11a/b/g/n	All devices passed
Linksys E3200 802.11a/b/g/n	All devices passed
Apple Airport Extreme 802.11a/b/g/n	All devices passed
Asus RT-N56U 802.11a/b/g/n	• Toshiba BDX3300KU failed to connect via WPS • LG BP320 failed to connect to Open-None security
D-Link DIR 601 802.11b/g/n	All devices passed
D-Link DIR 655 802.11b/g/n	All devices passed
Motorola SBG6580 802.11a/b/g/n	• Samsung BDE5700 failed to connect via WPS

NOTE:

- All AP's were upgraded to the latest SW/FW
- Tested ~15ft from AP

Appendix – Reference Data

Allion Scorecard (Total Points)

DUT	Startup Time (2 tests)	Features (1 test)	App. Load Time (6 tests)	Longevity (1 test)	Chamber (3 tests)	OTA Exp. (6 tests)	AP IOP (1 test)	Total (20 tests)	Rankings
Panasonic DMP-BDT220	13/20	7/10	20/60	10/10	13/30	39/60	10/10	112/200	10th
Panasonic DMP-BDT500	13/20	10/10	29/60	10/10	17/30	25.5/60	10/10	114.5/200	9th
Panasonic DMP-BDT320	13/20	7/10	33/60	10/10	19/30	38.5/60	10/10	130.5/200	5th
Samsung BDE5400	8/20	1/10	24/60	10/10	19/30	38.5/60	10/10	110.5/200	11th
Samsung BDE5700	8/20	5/10	10/60	3/10	7/30	14/60	7/10	54/200	13th
Samsung BDE5900	12/20	5/10	37/60	3/10	21/30	37.5/60	10/10	125.5/200	6th
Samsung BDE6500	10/20	10/10	37/60	10/10	9/30	38/60	10/10	124/200	7th
Sony BDP-S3100	11/20	5/10	45/60	10/10	22/30	39/60	10/10	142/200	1st
Sony BDP-S5100	11/20	5/10	45/60	10/10	22/30	37.5/60	10/10	140.5/200	2nd
Toshiba BDX3300KU	8/20	3/10	36/60	10/10	19/30	53.5/60	7/10	136.5/200	3rd
LG BP320	8/20	5/10	17/60	10/10	13/30	37/60	7/10	97/200	12th
LG BP520	13/20	5/10	32/60	10/10	24/30	38/60	10/10	132/200	4th
LG BP620	11/20	5/10	34/60	10/10	13/30	38.5/60	10/10	121.5/200	8th

Feature Set Comparison

DUT	Features
MAXIMUM SCORE	**10**
Panasonic DMP-BDT220	7
Panasonic DMP-BDT500	10
Panasonic DMP-BDT320	7
Samsung BDE5400	1
Samsung BDE5700	5
Samsung BDE5900	5
Samsung BDE6500	10
Sony BDP-S3100	5
Sony BDP-S5100	5
Toshiba BDX3300KU	3
LG BP320	5
LG BP520	5
LG BP620	5

System Startup Time

DUT	System Startup Time	
	Time for UI to Become Available	Time to 1st Ping
MAXIMUM SCORE	**10**	**10**
Panasonic DMP-BDT220	3	10
Panasonic DMP-BDT500	3	10
Panasonic DMP-BDT320	3	10
Samsung BDE5400	7	1
Samsung BDE5700	1	7
Samsung BDE5900	7	5
Samsung BDE6500	5	5
Sony BDP-S3100	1	10
Sony BDP-S5100	10	1
Toshiba BDX3300KU	5	3
LG BP320	7	1
LG BP520	10	3
LG BP620	10	1

Application / Media Load Time

DUT	Application Load Times			Time to Start Streaming		
	Netflix	Pandora	YouTube	Netflix	Pandora	YouTube
MAXIMUM SCORE	**10**	**10**	**10**	**10**	**10**	**10**
Panasonic DMP-BDT220	3	5	7	3	1	1
Panasonic DMP-BDT500	3	5	10	3	1	7
Panasonic DMP-BDT320	3	7	10	3	3	7
Samsung BDE5400	5	3	1	3	7	5
Samsung BDE5700	1	1	1	5	1	1
Samsung BDE5900	7	1	5	7	10	7
Samsung BDE6500	7	1	5	7	10	7
Sony BDP-S3100	10	10	7	7	1	10
Sony BDP-S5100	10	10	7	7	1	10
Toshiba BDX3300KU	5	7	7	3	7	7
LG BP320	1	1	1	1	10	3
LG BP520	5	3	5	5	7	7
LG BP620	5	5	5	5	7	7

Reliability / Longevity

DUT	Longevity
MAXIMUM SCORE	**10**
Panasonic DMP-BDT220	10
Panasonic DMP-BDT500	10
Panasonic DMP-BDT320	10
Samsung BDE5400	10
Samsung BDE5700	3
Samsung BDE5900	3
Samsung BDE6500	10
Sony BDP-S3100	10
Sony BDP-S5100	10
Toshiba BDX3300KU	10
LG BP320	10
LG BP520	10
LG BP620	10

Wi-Fi Signal Attenuation vs. Media Streaming Experience

DUT	YouTube (dB)	Score	Netflix (dB)	Score	Ping Response Range (dB)	Score
MAXIMUM SCORE	**-**	**10**	**-**	**10**	**-**	**10**
Panasonic DMP-BDT220	41	5	39	5	42	3
Panasonic DMP-BDT500	42	5	45	7	52	5
Panasonic DMP-BDT320	45	7	44	7	49	5
Samsung BDE5400	46	7	48	7	49	5
Samsung BDE5700	23	1	25	1	47	5
Samsung BDE5900	43	7	43	7	58	7
Samsung BDE6500	30	1	37	5	44	3
Sony BDP-S3100	42	5	53	10	54	7
Sony BDP-S5100	42	5	50	10	54	7
Toshiba BDX3300KU	47	7	48	7	50	5
LG BP320	36	3	38	5	47	5
LG BP520	46	7	49	10	57	7
LG BP620	34	3	39	5	48	5

Over-The-Air (OTA) User Experience

DUT	OTA PHY Rate (Mbps)						OTA User Experience
	Kitchen		Bedroom #2		Bedroom #5		
	YouTube	Netflix	YouTube	Netflix	YouTube	Netflix	
MAXIMUM SCORE	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**45**
Panasonic DMP-BDT220	1.25	1.25	1.25	1.25	1.25	1.25	31.5
Panasonic DMP-BDT500	1.25	1.25	1.25	1.25	1.25	1.25	18
Panasonic DMP-BDT320	1.25	1.25	0.75	1.25	1.25	1.25	31.5
Samsung BDE5400	1.25	1.25	1.25	1.25	1.25	0.75	31.5
Samsung BDE5700	1.25	1.25	0.25	0.75	0.75	0.75	9
Samsung BDE5900	0.75	1.25	0.75	1.25	0.75	1.25	31.5
Samsung BDE6500	1.25	1.25	0.75	0.75	1.25	1.25	31.5
Sony BDP-S3100	1.25	1.25	1.25	1.25	1.25	1.25	31.5
Sony BDP-S5100	0.75	1.25	0.75	1.25	0.75	1.25	31.5
Toshiba BDX3300KU	1.75	1.75	1.25	1.25	1.25	1.25	45
LG BP320	1.25	1.25	0.75	0.75	0.75	0.75	31.5
LG BP520	1.25	1.25	0.75	1.25	0.75	1.25	31.5
LG BP620	1.25	1.25	0.75	1.25	1.25	1.25	31.5

AP Interoperability

DUT	AP IOP
MAXIMUM SCORE	**10**
Panasonic DMP-BDT220	10
Panasonic DMP-BDT500	10
Panasonic DMP-BDT320	10
Samsung BDE5400	10
Samsung BDE5700	7
Samsung BDE5900	10
Samsung BDE6500	10
Sony BDP-S3100	10
Sony BDP-S5100	10
Toshiba BDX3300KU	7
LG BP320	7
LG BP520	10
LG BP620	10

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